SOLAR OBSERVATIONS

SOLAR RADIATION MEASUREMENTS DURING DECEMBER 1933

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For a description of instruments employed and their exposures, the reader is referred to the January 1932 REVIEW, page 26.

Beginning with this issue weekly means of solar radiation (direct + diffuse) received on a horizontal surface at Mount Washington, N.H. (lat. 44°16′15″ N., long. 71°18′13″ W., elevation 1,911 meters) will be regularly included in table 2 through the courtesy of the Blue Hill Meteorological Observatory of Harvard University.[1] It may be that complete records of solar radiation at Mount Washington will be difficult to obtain; for example the average wind velocity at that station for December last was 59 m.p.h., while the average temperature was 9.9 ° F., and on December 29 the temperature dropped to 46.2° below zero. The average wind velocity on Christmas Day was 115 m.p.h. With such climatic conditions it is easy to understand the difficulties of keeping in continuous operation a thermoelectric receiver and its recorder.

We regret that the completion of solar radiation studies at Gainesville, Fla., prevents the continuation of the publication of solar data from that station. Much credit is due to Mr. Fred H. Hull of the University of Florida for his efforts in keeping this station in operation until the end of December 1933 in order to complete for us the year's record.

Table 1 shows that solar radiation intensities averaged close to normal for December at all three stations for which normals have been computed.

Table 2 shows an excess in the total solar and sky radiation received on a horizontal surface at Twin Falls, Gainesville, and Miami, and a deficiency at all other stations for which we have normals. A marked excess of radiation for the year was received at all stations with the exception of Madison, Pittsburgh, and Miami.

Turbidity measurements were obtained on the 1st, and 7th only and although these were the clearest days of the month, the readings indicate considerable turbulence.

Polarization measurements obtained on four days at Washington give a mean of 60 percent, with a maximum of 62 percent on the 11th. At Madison, measurements on two days give a mean of 72 percent with a maximum of 74 percent on the 6th. Snow-covered ground prevented further readings at this latter station. The mean value at Washington is slightly higher than normal for December; the other three readings are close to normal for the month.

[1] This table was compiled by Dr. B. Haurwitz of Blue Hill Observatory from observations obtained by the Mount Washington Observatory with Eppley pyrheiometer and Engelhard recording microammeter.

TABLE 1.—*Solar radiation intensities during December 1933*

[Gram-calories per minute per square centimeter of normal surface]

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A.M.					P.M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	1.0[1]	2.0	3.0	4.0	5.0	e.
	mm	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*mm*
WASHINGTON, D.C.											
Dec. 1				1.04	1.19						
Dec. 7			0.93	1.16							
Dec. 11							1.28	1.02	0.78		
Dec. 27			1.08	1.17	1.44			1.20			
Means			(1.00)	1.12	1.32		(1.28)	(1.11)	(.78)		
Departures			+.09	+.07	+.09		−.04	+.07	−.13		
MADISON, WIS.											
Dec. 6		0.99	1.03	1.26	1.37						
Dec. 18		.86	.96	1.21	1.40			1.20			
Dec. 26				1.30							
Dec. 28				1.35							
Means		(.92)	(1.00)	1.28	(1.38)			(1.20)			
Departures		−.01	−.09	+.07	+.02			−.03			
LINCOLN, NEBR.											
Dec. 5									1.10	1.02	
Dec. 7				1.10	1.35			1.21	1.09	0.91	
Dec. 8		1.06	1.16	1.30				1.17	1.07	.99	
Dec. 15		.84	1.08	1.27	1.38				.97	.90	
Dec. 16		.76	.92	1.13	1.32			1.24	1.08	.95	
Dec. 18		1.07	1.20	1.38				1.29	1.16	1.04	
Dec. 22								1.17	1.04	.91	
Dec. 23								1.15			
Dec. 26				1.36							
Dec. 27		.85	.97	1.18				1.06	.92	.70	
Means		.92	1.07	1.25	(1.35)			1.18	1.05	.93	
Departures		−.01	+.01	+.02	−.03			−.02	−.02	−.03	
BLUE HILL, MASS.											
Dec. 2	3.4							1.02	0.87	0.76	3.0
Dec. 7	3.3			1.17	1.29		1.27				3.2
Dec. 12	.7			1.36	1.45						.7
Dec. 14	2.0						1.15	.99	.84		1.4
Dec. 16	4.0						1.31	1.04	.85	.72	4.5
Dec. 18	4.6						1.32	1.08	.89		3.3
Dec. 28	1.0						1.38	1.18	1.02	.89	1.0
Means				1.26	1.37		1.29	1.06	.89	.79	

[1] Extrapolated.

TABLE 2.—*Average daily totals of solar radiation (direct+diffuse) received on a horizontal surface*

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Pittsburgh	Fairbanks	Twin Falls	La Jolla	Gainesville	Miami	New Orleans	Riverside	Blue Hill	Mount Washington
1933	Gram calories per square centimeter															
	cal	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*	*cal*
Dec. 3	148	82	202	77	47	207	104	11	157	303	227	322	240	259	66	90
Dec. 10	107	92	140	70	101	160	69	4	124	246	268	335	226	224	127	136
Dec. 17	117	107	208	89	73	160	65	3	153	315	276	302	236	277	120	95
Dec. 24[1]	166	114	152	69	145	83	82	6	136	175	218	286	152	210	147	64
	Departures from weekly normals															
Dec. 3	−12	−36	+24	−11	−49	+17	+20		+39	−2	+12	+23				
Dec. 10	−34	−21	−28	−13	+10	−12	−2		+22	−57	+64	+39				
Dec. 17	−31	−14	+25	+7	−20	+7	−6		+52	+17	+88	+19				
Dec. 24	+18	−9	−32	−15	+48	−57	−2		+15	−96	−31	+4				
	Accumulated departures at the end of year															
	+6,409	−1,976	+5,687	+14,566	+9,855	+10,338	−1,710		+3,431	+8,199		−4,155				
	Percentage departures at end of year															
	+5.2	−1.7	+4.2	+12.3	+10.0	+6.3	−1.7		+2.4	+6.4		−2.6				

[1] 8-day means.

TABLE 3.—*Solar radiation measurements, and determinations of atmospheric turbidity factor, β, Washington, D.C., December 1933*

[Values in italics have been interpolated]

Date and solar hour angle	Solar altitude, h.	Air mass, m.	I_m	I_y	I_r	β	Blueness of sky	Note: Skylight polarization, P., clouds, etc.
Dec. 1								
			gr. cal	*gr. cal*	*gr. cal*			
2:31a	19–40	2.95	1.041	*0.803*	0.667	0.080	5	
2:25a	20–25	2.85	1.096	.806	*.669*	.065		
0:29a	28–53	2.06	1.198	.881	*.725*	.088		
0:24a	29–01	2.06	1.181	*.885*	.727	.095		P=56.6
Dec. 7								
2:46a	18–08	3.19	1.116	*.857*	.716	.120	6	
2:39a	18–56	3.06	1.158	.858	*.720*	.105		P=60.4

TABLE 4.—*Solar radiation measurements obtained at Blue Hill Meteorological Observatory of Harvard University during December 1933*

[I_m=intensity in the whole spectrum; I_y=intensity transmitted by yellow glass screen OG_1; I_r=intensity transmitted by red glass screen RG_2]

Date and solar hour angle	Solar altitude, h.	Air mass, m.	I_m	I_y	I_r	Sky conditions. (Clouds, haze (hz), visibility (v), wind, etc.). International symbols are employed for wind direction and velocity, and kind of clouds.
Dec. 2	° ′		*gr. cal*	*gr. cal*	*gr. cal*	
3:29, p.m.	9 44	5.75	0.720	0.580	0.490	2 Ci; hz; v 8; WNW–3.
Dec. 7						
0:58, a.m.	23 55	2.46	1.224	.909	.747	1 Acu, few Frcu; dns hz; v 7; NW–7.
0:42, p.m.	24 26	2.41	1.210	.873	.706	2 Ci, 1 Cu; solar corona; v 7; NW 7–8.
Dec. 14						
1:30, p.m.	21 20	2.74	1.026	.770	.621	No clouds; v 6; NNE–1.
2:44, p.m.	14 26	3.97	.842	.634	.522	
Dec. 16						
1:14, p.m.	22 16	2.62	1.135	.854	.676	1 Ci; v 6; WSW–3.
2:31, p.m.	15 46	3.63	.908	.692	.588	1 Ci; v 6; W–3.
Dec. 28						
2:40, p.m.	14 47	3.86	1.004	.793	.664	Few Frcu; lt hz; v 8; WSW–5.

POSITIONS AND AREAS OF SUN SPOTS

[Communicated by Capt. J. F. Hellweg, Superintendent U.S. Naval Observatory. Data furnished by Naval Observatory, in cooperation with Harvard, Perkins, and Mount Wilson Observatories. The differences of longitude are measured from central meridian, positive west. The north latitudes are plus. Areas are corrected for foreshortening and are expressed in millionths of sun's visible hemisphere. The total area, including spots and groups, is given for each day in the last column]

Date	Eastern standard civil time	Heliographic			Area		Total area for each day
		Diff. long.	Longitude	Latitude	Spot	Group	
1933	h. m.	°	°	°			
Dec. 1 (Naval Observatory)	12 15		No spots				
Dec. 2 (Naval Observatory)	12 16		No spots				
Dec. 4 (Naval Observatory)	13 10		No spots				
Dec. 5 (Mount Wilson)			No spots				
Dec. 6 (Mount Wilson)			No spots				
Dec. 7 (Naval Observatory)	12 29		No spots				
Dec. 8 (Naval Observatory)	11 9		No spots				
Dec. 9 (Mount Wilson)			No spots				
Dec. 10 (Naval Observatory)	11 46		No spots				
Dec. 11 (Naval Observatory)	11 27	−19.0	186.7	+2.0		28	28
Dec. 12 (Harvard Observatory)			No spots				
Dec. 13 (Harvard Observatory)			No spots				
Dec. 14 (Naval Observatory)	13 20		No spots				
Dec. 15 (Mount Wilson)			No spots				
Dec. 16 (Mount Wilson)			No spots				
Dec. 17 (Mount Wilson)			No spots				
Dec. 18 (Naval Observatory)	13 3		No spots				
Dec. 19 (Mount Wilson)			No spots				
Dec. 20 (Mount Wilson)			No spots				
Dec. 21 (Naval Observatory)	11 46		No spots				
Dec. 22 (Naval Observatory)	10 40		No spots				
Dec. 23 (Naval Observatory)	10 52		No spots				
Dec. 24 (Naval Observatory)	13 20		No spots				
Dec. 25 (Naval Observatory)	11 10		No spots				
Dec. 26 (Mount Wilson)			No spots				
Dec. 27 (Naval Observatory)	10 29		No spots				
Dec. 28 (Naval Observatory)	14 39		No spots				
Dec. 29 (Naval Observatory)	15 3		No spots				
Mean daily area for December							1

PROVISIONAL SUN-SPOT RELATIVE NUMBERS FOR DECEMBER 1933

[Dependent alone on observations at Zurich and its station at Arosa]

[Data furnished through the courtesy of Prof. W. Brunner, Eidgenössische Sternwarte, Zurich, Switzerland]

December 1933	Relative numbers	December 1933	Relative numbers	December 1933	Relative numbers
1	0	11	*Mc* 9	21	0
2	0	12	0	22	0
3	0	13	0	23	0
4	0	14	0	24	0
5	0	15		25	0
6	0	16	0	26	0
7	0	17	0	27	0
8	0	18	0	28	0
9	0	19	0	29	0
10	0	20	0	30	0
				31	0

Mean: 30 days = 0.3.

c=New formation of a center of activity: *M*, in the central zone.